anal tergite scarcely covering the valves, which have their borders prominent and deeply compressed; *sternite* large and angular.

Legs long and slender.

Number of segments 55.

Length about 70 millim., width 5·5.

Loc. Ki Dulau (Ki Islands).

This species, of which a single female specimen was obtained, in colouring resembles *Sp. sanguineus* of C. Koch (Die Myriop. i. p. 16, fig. 15). It, however, at least differs in its long legs and antennæ and prominent anal valves.

EXPLANATION OF PLATE IX.

Fig. 1. *Strongylosoma Gervaisii* (Lucas). Dorsal view, × 1½. In this figure the anterior angles of the keels are too squared and the legs are wrongly placed and wrong in number.
Fig. 1 *a*. Ditto. Left copulatory foot from below.
Fig. 2. *Strongylosoma Guérinii*, Gerv. Left copulatory foot from below.
Fig. 3. *Stenonia tuberosa*, sp. n. Keel of the twelfth segment from above.
Fig. 3 *a*. Ditto. Anal segment from above.
Fig. 3 *b*. Ditto. Copulatory foot from below.
Fig. 4. *Iulus solitarius*, sp. n. Anal segment from the side.
Fig. 5. *Iulus tristani*, sp. n. Anal segment from the side.
Fig. 5 *a*. Ditto. Part of segment to show position of pore.
Fig. 6. *Spirostreptus Moseleyi*, sp. n. Lateral view of head and collum, ×.
Fig. 6 *a*. Ditto. Lateral view of anal segment.
Fig. 7. *Acanthiulus Murrayi*, sp. n. Lateral view of anterior end of body, ×.
Fig. 7 *a*. Ditto. Lateral view of two of the middle segments.
Fig. 7 *b*. Ditto. Lateral view of posterior end of body.
Fig. 8. *Spirobolus dorsalis* (Le Guillou). Lateral view of head, ×.
Fig. 9. *Spirobolus digrammus*, sp. n. Lateral view of head and collum, ×.
Fig. 9 *a*. Ditto. Lateral view of anal segment, ×.
Fig. 9 *b*. Ditto. Anterior view of copulatory feet.
Fig. 10. *Spirobolus challengeri*, sp. n. Lateral view of head and collum, ×.
Fig. 10 *a*. Ditto. Lateral view of anal somite, ×.
Fig. 10 *b*. Ditto. Third leg of male.
Fig. 10 *c*. Ditto. Anterior view of copulatory feet.
Fig. 11. *Spirobolus flavo-collaris*, sp. n. Lateral view of anal segment, ×.
Fig. 11 *a*. Ditto. Anterior view of copulatory feet.
Fig. 12. *Spirobolus hæmorrhantus*, sp. n. Lateral view of head and collum, ×.
Fig. 12 *a*. Ditto. Lateral view of anal segment, ×.

XVII.—*The Influence of Light on the Coloration of Crustaceans.* By A.-E. Malard *.

M. Martin has recently drawn the attention of our Society to a peculiar case of albinism which he had studied in a lobster

* Translated from the 'Bulletin de la Société Philomathique de Paris,' 8ième série, t. iv. no. 1 (Paris, 1892), pp. 24-30.

observed at St.-Vaast-la-Hougue. In this lobster the absence of pigment did not extend to the eyes, which had preserved their ordinary colour. This phenomenon is not confined to the lobster, but seems to be even of very frequent occurrence in other crustaceans, such as the common edible crab (*Cancer pagurus*) *, in which I have met with very numerous examples of it in the young individuals living beneath the stones of the old oyster-beds near the Isle of Tatihou.

This more or less complete absence of pigment seems to be related to the nature of the habitat of these animals; the fossorial crustaceans, such as *Gebia*, *Axia*, and *Callianassa*, are almost entirely white, and the greater portion of those which live in grottos or crannies of rocks likewise assume similar tints. In the lobster especially considerable differences of hue have been observed by Mr. E. Lovett † in the neighbourhood of the Channel Islands; he has described one specimen in particular, which was "of a pale lavender," with a mauve patch on the cephalothorax, and the chelæ of a bright pale blue. This lobster, which had been sent to him alive by M. Sinel, of Jersey, was still living when he examined it: it was a female with eggs. Mr. Lovett also mentions other colours in the lobster—white spotted with blue, "dappled blue and grey," uniform grey, and finally a curious variety of a pale reddish colour with the antennæ "of a decided bright red." It was maintained at a certain period by Bell that the variations in colour are purely local, each race of lobster thus having a peculiar facies, so much so that a Jersey lobster would be distinguished at once from a French one; the fact in itself is certainly true, but only arises from the different conditions of medium which the animals meet with at different places. As is remarked by Lovett, the coloration must be related to the depth of the water, which allows more or less light to penetrate, and also to the number of the grottos and natural crannies, which, as we know, are very numerous at certain points of the coast of the Channel Islands, as, for instance, in Sark.

I therefore think that these cases of pseudo-albinism in lobsters, such as that of the roseate specimen of Mr. Lovett, the greenish-white individual which has been reported to us by M. Martin, and finally the one which M. Bietrix has told us is under observation at Concarneau, are only normal individuals which have lost their pigment of the cyanic series as

* Cases of melanism in the same species, due to injury to the derm, are also met with; the crab becomes entirely black, or "charbonné" as the French sailors say.

† 'Zoologist,' ser. 3, vol. viii., 1884, p. 491; and ser. 3, vol. ix., 1885, p. 102.

an actual consequence of the insufficiency of light in the medium in which they have lived.

Far from stopping here, indeed, the influence of light on the coloration of crustaceans is enormous, and we may say that, as an almost general rule, the animals belonging to this class have a tendency to vary the coloration of their bodies according to the coloration of the surrounding medium.

Moreover this chromatic adaptation of the animal to the ambient medium seems to be effected in two different fashions :—

1. *By chemical means*, that is to say, by the modification of a pigment under the direct influence of light.

2. *By physiological means*, that is, by the action of pigment-cells or chromatoblasts working under the influence of light, but indirectly, and by the intervention of a sort of reflex process which actually originates from the eyes of the animal.

Chromatic adaptation is met with in many Copepods, Amphipods, Isopods, and Macrura; it appears to be of less common occurrence in the Brachyura, where it is often replaced by another form of mimicry.

As long ago as 1863 Claus mentioned the changes of colour which are undergone by Copepods belonging to the genus *Sapphirina*. According to this author, in the Copepods of this genus the shield can assume changing colours, which the animal varies according to the media in which it happens to be. One species alone forms an exception to the rule and seems to be devoid of this power of mimicry. In the greater portion of the others the male alone is endowed with this power *. In 1867 an analogous statement was made by Sars with regard to Copepods of the Norwegian coasts †. And, lastly, at a more recent date the same phenomenon was observed by Herrick in the case of *Diaptomus castor* ‡.

The changes of colour in *Squilla* and *Mysis*, under the influence of light, have been known for a very long time; they have formed the subject of recent papers by Weber § and Schmidlein‖, and I merely mention them here in passing.

Among the Isopods the phenomenon is most interesting and easiest to determine in the genus *Idotea*.

In the line of foam and floating sea-weed which distin-

* Claus, 'Die freilebenden Copepoden,' 1863, p. 35.

† G. O. Sars, 'Histoire Naturelle des Crustacés d'Eau douce de Norvège,' 1867, p. 23.

‡ Herrick, 'American Naturalist,' vol. xvii. p. 381.

§ Weber, Archiv f. mikr. Anat. Bd. xix. pp. 591, 597.

‖ Schmidlein, Mittheilungen zool. Stat. Neapel, Bd. i., 1879, p. 513.

guishes the flood-tide from the ebb, it is not unusual to find a somewhat large quantity of a floating weed, *Halidrys siliquosa*, and nearly always there are to be found in this alga considerable numbers of an Isopod Crustacean, *Idotea marina*, which in the general shape of its body, and especially in colour, bears a deceptive resemblance to the brownish elongate elliptical floats of the weed, which have gained the latter its name. This property of chromatic mimicry which is possessed by *Idotea marina* seems to be shared by several other species of the genus. In the case of *Idotea tricuspidata*, a species which is very common in the vicinity of Saint-Vaast, and especially on the tower which serves as a beacon at the Dranguet reefs, it is not difficult to ascertain that the individuals which live in the acorn-barnacle zone are usually of quite a different colour from those living amidst the mussels which cover the base of the tower, and that the latter likewise generally differ in tint from those which are to be met with among the *Ulva*.

P. Mayer has observed these changes of colour in specimens of *Idotea tricuspidata* in one of the tanks at the Naples Zoological Station *, and has found that the same animals change colour according to the objects which surround them, and that in the space of half an hour.

If in some way or other the animal is rendered blind, as by extirpating the eyes for example, this curious adaptation does not take place. Carl Matzdorff †, who has studied very thoroughly the colour-variations of *Idotea tricuspidata*, has shown that these changes are due to chromatoblasts which possess the power of expansion and contraction. The individuals which live upon algæ or hydroids are, according to his observations, in the majority of cases less highly coloured than those which run about on the bottom. Matzdorff even succeeded in causing specimens of *Idotea* to change colour by the experiment of placing them in differently coloured glasses.

Perhaps this adaptation to the general colour of the ambient medium is to be regarded as the cause of the coloration observed in that singular blue pelagic species *Idotea annulata*; at any rate its commensalism with a *Physalia* which is likewise blue would explain this mimicry ‡. Several Læmodipoda, including species of *Proto*, *Protella*, and *Caprella* §,

* P. Mayer, Mittheilungen zool. Stat. Neapel, Bd. i. pp. 520, 521.

† Matzdorff, "Ueber die Färbung von *Idotea tricuspidata*" (Dissert. inaug., Jena, 1882), Jenaische Zeitschrift, Bd. xvi. p. 158.

‡ Spence Bate, Ann. & Mag. Nat. Hist. ser. 4, vol. i., 1868, pp. 443, 447, pl. xxi. fig. 1.

§ *Proto pedata*, Flem., *Protella phasma*, Latr., *Caprella æquilibra*, Spence Bate and Westwood; Haller, Zeitschr. f. wiss. Zool. Bd. xxxiii. 1879, p. 391.

likewise mimic to a deceptive degree, as I have very often been enabled to observe, the ramifications of the algæ on which they are found. M. E. Chevreux * has already mentioned the singular adaptation which is exhibited in particular by *Caprella acutifrons* to *Cystocira granulata*, the sea-weed which is most often green with yellow spots (as at Les Jonchères, near the Croisic); the *Caprella* is seen to assume the same colour and to cover itself with yellow spots of the same shade and arranged in the same fashion; while at other points of the coast, where the algæ are red, it assumes a uniform brownish-red tint, identical with that of the sea-weed upon which it lives (as at Baie d'Eslandes, near the Croisic). For a long time it was believed that the food of the animal was responsible for these changes in coloration; but in a case like the present it is very evident that, as M. Chevreux remarks, the colour of the *Caprella* cannot be attributed to the nature of its food †, since it is an exclusively predaceous animal. It may be that we ought rather to regard this similitude of form and colour as indicating a sort of rational act on the part of the animal, which seeks a favourable place to hide itself, and actually chooses the alga on account of its shape, not adapting itself as regards colour until afterwards.

In *Hippolyte*, a genus allied to *Palæmon* but of a slightly smaller size, the adaptation of colour seems likewise to be related to the choice of habitat; thus *Hippolyte varians*, which owes its name to these changes of coloration, will be green in *Zostera*, brown in *Fucus*, red in *Floridea*, and transparent or almost transparent when it is found amidst *Antennularia* and *Sertularia*.

Now what is the cause of these changes of colour?

It seems to be the same as that of the coloration of the algæ. As a matter of fact experiments which have been made upon this subject have proved that the same specimen of *Hippolyte* assumes a red tint in complete darkness, while in bright light it becomes a vivid emerald-green colour, and semi-obscurity renders it brown. These experiments, which I have myself repeated, would appear decisive. I am bound, however, to state that I have met with a case which strangely complicates the question.

Thanks to the courtesy of the Board of Bridges and Highways (Buoying Service of the Arrondissement of Cherbourg), and especially to the extreme kindness of M. Rouland, who is

* E. Chevreux, 'Les Plages du Croisic,' par Adrien Dolfuss, pp. 9 and 11.

† This remark had already been made in the case of *Idotea* by Möbius, Bericht Exped. 'Pommerania,' p. 121.

especially intrusted with this service, I have been enabled for several years past to be present at the picking up of the buoys included in the district of La Hougue: upon one of these it was my fortune to observe an immense quantity of *Comatula* (*Antedon rosacea*), with which the chain of the buoy was literally covered.

These specimens of *Comatula* were of three very distinct colours—more or less deep violaceous red, orange-yellow inclining towards saturn-red, and, lastly, alternately white and red with whitish pinnules. Now I was not a little surprised at observing along the chain of the buoy specimens of *Hippolyte* apparently living side by side with the feather-stars, which they in many cases clasped with their limbs, and agreeing, at least in the majority of instances, so closely with their neighbour in colour that it became difficult to perceive them.

The fact, strange as it is, is not unique. Lucien Joliet has recorded a similar faculty in a Mediterranean *Pontonia* living as a commensal with *Diazona*; this *Pontonia*, which is allied to *P. tyrrhena* and which Joliet has described as a new species under the name *P. diazonæ* *, also bears a deceptive resemblance to the *Diazona*; the transparency of its body blends with the hyaline jelly of the colony, and the yellow spots with which its thorax, abdomen, and chelæ are marked harmonize so perfectly with those of the Ascidian itself, that it becomes impossible to perceive its presence so long as it remains upon its host.

Specimens of *Palæmon* also exhibit variations in colour according to the nature of the bottom on which they are found, becoming green when the bottom is covered with *Zostera* and grey or reddish yellow when the bottom is of sand.

Some years ago M. Georges Pouchet made some very interesting observations upon this subject †. Taking some earthenware vessels coloured black and white inside, he placed in them for the purpose of observation some specimens of *Palæmon* of medium size (3 to 4 centim. in length), which experience had taught him to be most readily subject to variations of colour. These prawns, which on leaving the fishermen's nets are usually of a roseate or faint lilac tint, become colourless, or at the most faintly yellowish, in the vessels with a white bottom; while in the black vessels they become, on the contrary, dark brown.

* L. Joliet, "Observations sur quelques Crustacés de la Mediterranée," Arch. Zool. expér. t. x. p. 118.

† G. Pouchet, 'Journal d'Anatomie et de Physiologie,' 1872, t. iv. pp. 401-407; C. R. Acad. Sc. Paris, 20 mai, 1872.

The change of colour from the pale to the dark condition occupies but a few minutes; it is different with regard to the opposite process. During the disappearance of the deep reddish-brown tint to become pale yellow and almost transparent the observer noticed that the animal passed through an intense deep blue stage.

M. Pouchet has furnished the explanation of these phenomena * by showing how the action of two kinds of pigments took place in them; on the one hand the pigments of the xanthic series (red, orange, and yellow) by the action of the chromatoblasts, on the other the pigments of the cyanic series generally free and in solution. The removal of the eyes produces in *Palæmon* the same effect as a black bottom †.

In certain Brachyurous Crustaceans we again meet with facts of the same kind; but here they are less general and not so numerous. Fritz Müller ‡ mentions an instance in a Brazilian species of *Gelasimus* which is of a uniform greyish-brown colour in the female. In the male of this *Gelasimus* at the breeding-season the posterior portion of the cephalothorax is of a pure white, while the anterior region assumes a rich green colour, passing into dark brown; in the event of danger and on the animal being alarmed its colours are subject to modification in a few minutes, the white becoming dirty grey or even black and the green losing all its brilliancy. Not until we come to *Carcinus mœnas* do we find that similar facts have been reported; I have myself often observed that the crabs living upon a bottom clothed with *Ulva*, as at the mouth of the Serre, near St.-Vaast, for example, when angry have a more decidedly green tint on the dorsum of the cephalothorax than those which are met with among the stony bottoms of the old oyster-beds and in the *Laminaria*-zone, where they assume olivaceous hues, passing into dirty yellow and brownish red, a shade which is in perfect agreement with the general tone of the bottom. Messrs. Carrington and Lovett §, in recording analogous observations, state that they have been able to study the mechanism of the phenomena in the tanks of the Westminster aquarium; here again the facts observed are probably due to the action of chromatoblasts.

I do not know whether the chromatoblasts also play a similar part in the Mediterranean *Lambrus*, the curious

* C. R. 1878, t. lxxxvii. pp. 302–303.

† M. S. Jourdain has since shown that by removing the eyes and leaving the animal in the dark a red coloration is always obtained.

‡ According to Darwin, 'The Descent of Man,' French edition, p. 361 [2nd English ed., 1883, p. 271.]

§ Carrington and Lovett, 'Zoologist,' 1882, pp. 12 and 14.

mimicry of which has been described by M. de Varigny in the 'Revue Scientifique'*; it appears to me that this is probably the case, as also in *Portumnus variegatus*, which disappears almost completely upon coarse granitic sand, as I have myself been able to observe. Be that as it may, we see from these examples that concealment by isochromatic adaptation seems to be a very widely spread fact in the different orders of Crustacea, and that albinism in these animals appears to be only a particular case of a very much more general phenomenon of chromatic adaptation to the medium.

XVIII.—*Observations upon* Amœba, *with especial reference to the existence of an apparent Micro-nucleus in that Organism.* (Preliminary Communication.) By John E. S. Moore, A.R.C.S. (from the Huxley Research Laboratory, R. Coll. Sci. Lond.).

[Plate XII.]

Through the laborious investigations of Maupas, Bütschli, Hertwig, and others we are to-day pretty well acquainted with the minute structural peculiarities and life-history of the ciliate Protozoa. Regarded in the light of single cells these little beings present points of structure at once both strikingly different and similar to those apparent in the cells that build up the Metazoan tissues.

The karyokinetic division of the micro-nucleus ("Nebenkern," "endoplastule," "nucleolus") in the ciliate Infusoria is undoubtedly strictly comparable, step by step, with the similar process apparent in the cells of higher forms; but the coexistence of this structure itself with the macro-nucleus, which divides akinetically, is something totally unlike those conditions which ordinarily present themselves in Metazoan cells.

Our knowledge of the multitude of structures included under the somewhat comprehensive title of "Nebenkern" in the Metazoa is still in a sufficiently unedifying condition to render it impossible to say whether those remarkable bodies met with in the gland-cells of many animals, *i. e.* in the cells actively secreting, are normal or parasitic, or whether in such cells we may not have to deal with a third structure besides the

* de Varigny, 'Revue Scientifique,' 3e série, t. x. p. 92, 2e sem., 1885.